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Renewable Energy Transmission Initiative Phase 1B Work Group Meeting

Black & Veatch

Phase 1B Work Group

June 26, 2008

Agenda

- Actions taken last meeting
  - Resource Valuation Model
- Project characterization & identification
- Transmission Assumptions

Phase 1B Work Group Issues

- Energy price forecast –reference and sensitivities
- Net short calculation
- Resource valuation model review
- Project characterization & identification
- Transmission assumptions
- Uncertainty assumptions - cost and CF data by resource type
- Advise on sensitivity analyses and data

Today & Next week

TBD

TBD

Project Identification & Characterization

- Solar Thermal
- Solar Photovoltaic
- Wind
- Biomass
- Geothermal (next week)

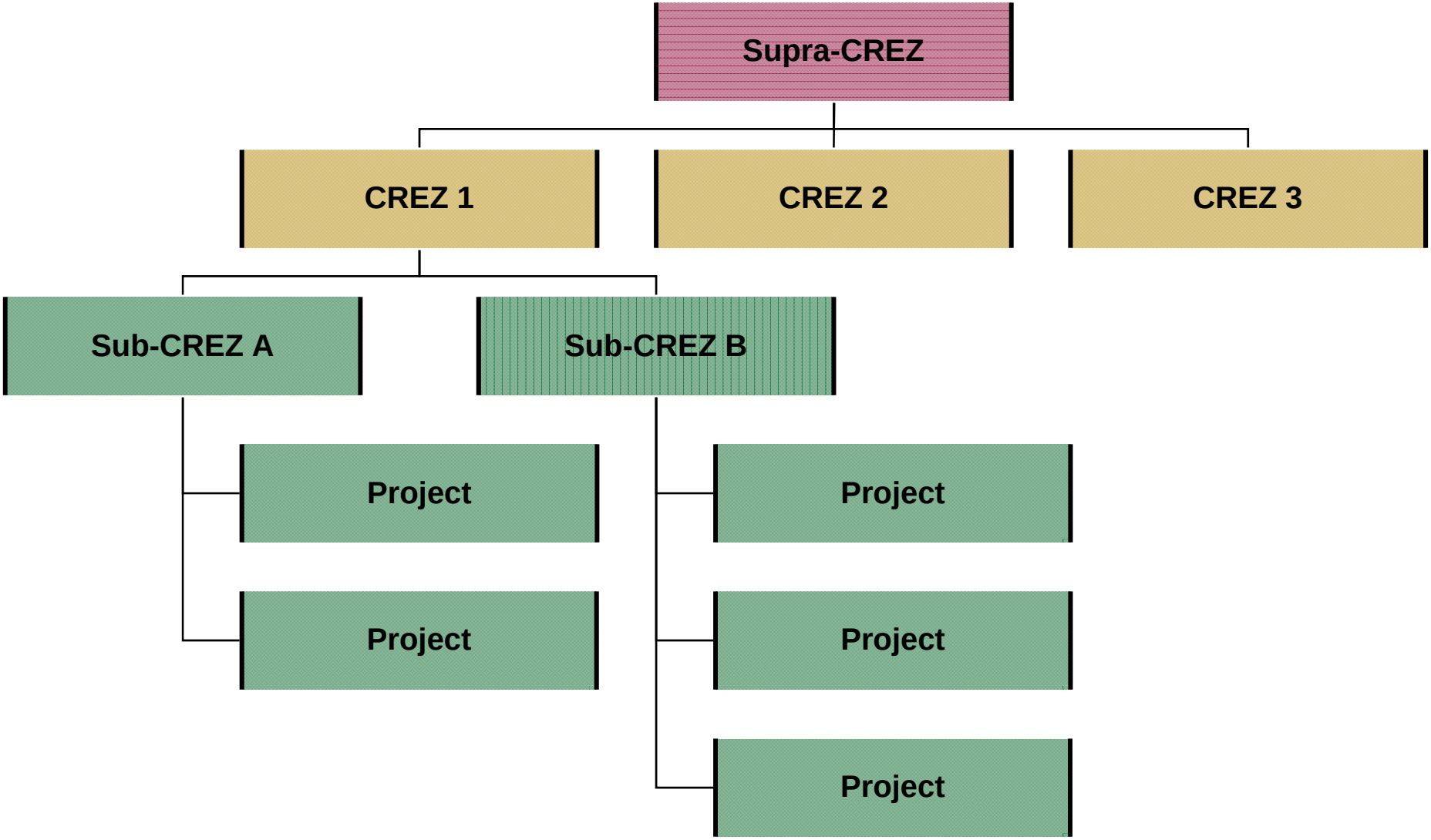
List of Screened Resources

	CA	OR	WA	NV	AZ	Baja California	British Columbia
Solid Biomass							
Solar Photovoltaic							
Solar Thermal				 (south)	 (west)		
Onshore Wind				 (south)		 (north)	
Geothermal							

Generation Project Characteristics

- Location
- Net plant output
- Capital costs
- Fixed operation and maintenance
- Variable operation and maintenance
- Heat rate (if applicable)
- Fuel costs (if applicable)
- Capacity factor
- Generation profile
- Land use
- Water use
- Where possible, identification of the affected sensitive species, such as bird and bat populations, or endangered species (this will be done based on GIS-information developed by the Environmental Working Group and the proposed project location)
- Air emissions

RETI "Crezology"



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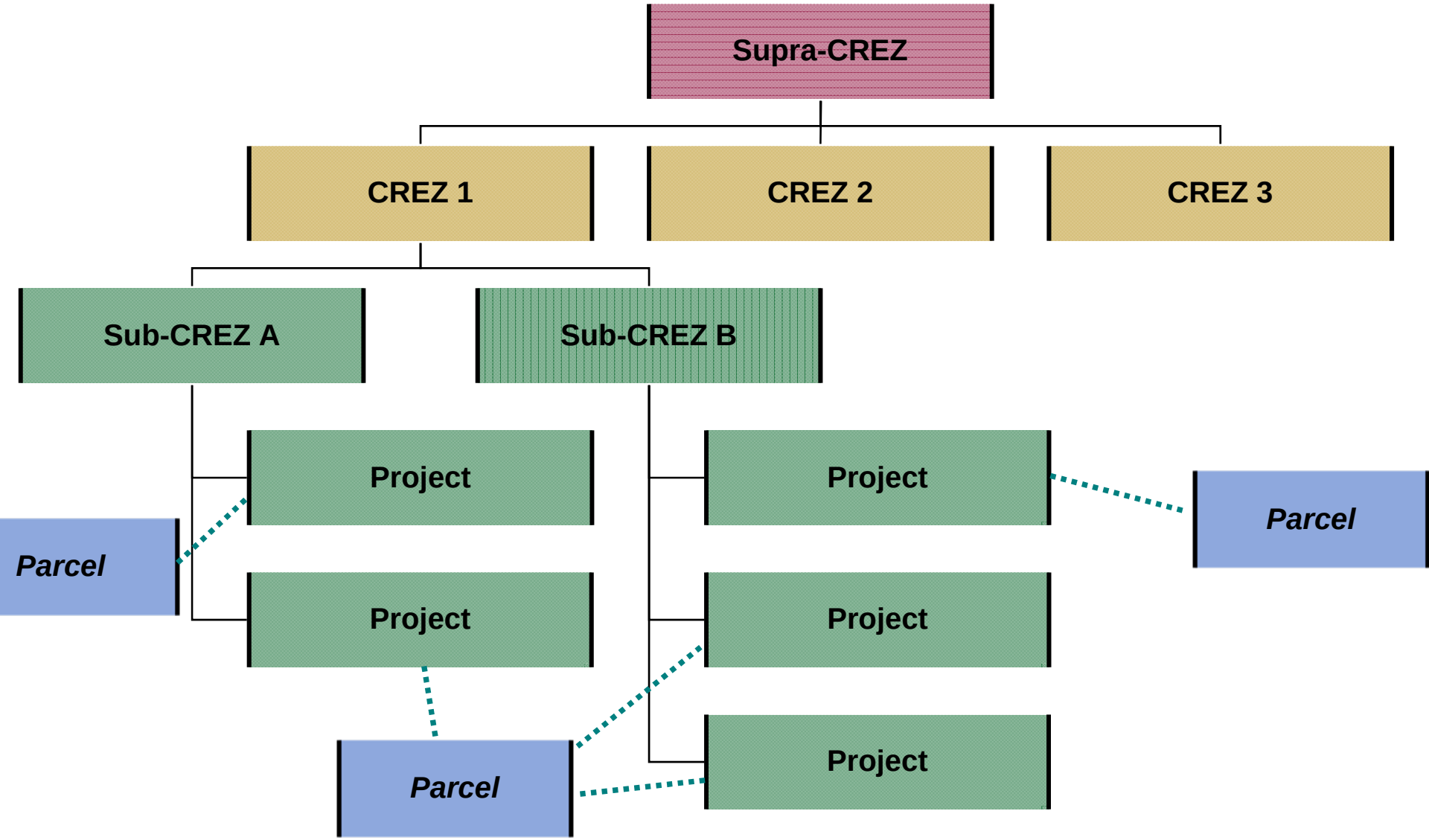


Pisgah Example

CONCEPTUAL – FOR EXAMPLE ONLY

Project Identification and Characterization – Solar Thermal

Identified Projects

RETI will model projects in California for which there is commercial interest. The list will be consolidated from:

- Bureau of Land Management applications
  - Precise location where available, approximate location based on description where necessary
- CAISO and POU transmission queues
  - Approximate location based on nearest reasonable site to interconnection point.
- Other publicly available data sets (PPAs and permitting)
- Generator-provided data

Project Identification and Characterization – Solar Thermal

Proxy Projects

- Proxy projects will be developed in California as necessary to populate the analysis
  - Located on environmentally appropriate parcels

Out of State Projects

- Parcels with known commercial interest will be used to model projects in NV and AZ
- Import limitation is 2,500 MW in 2020

Project Identification and Characterization – Solar Thermal

All solar thermal projects will be modeled as a solar trough plant

- No thermal storage
- Dry cooled by default, wet cooled only where an acceptable water source is proven

Capital Costs

Project capital cost may be adjusted for:

- Site topography which would result in increased earthmoving costs (slope >1%)
- Significant road construction required to access site
- Wet / dry cooling

Project Identification and Characterization – Solar Thermal

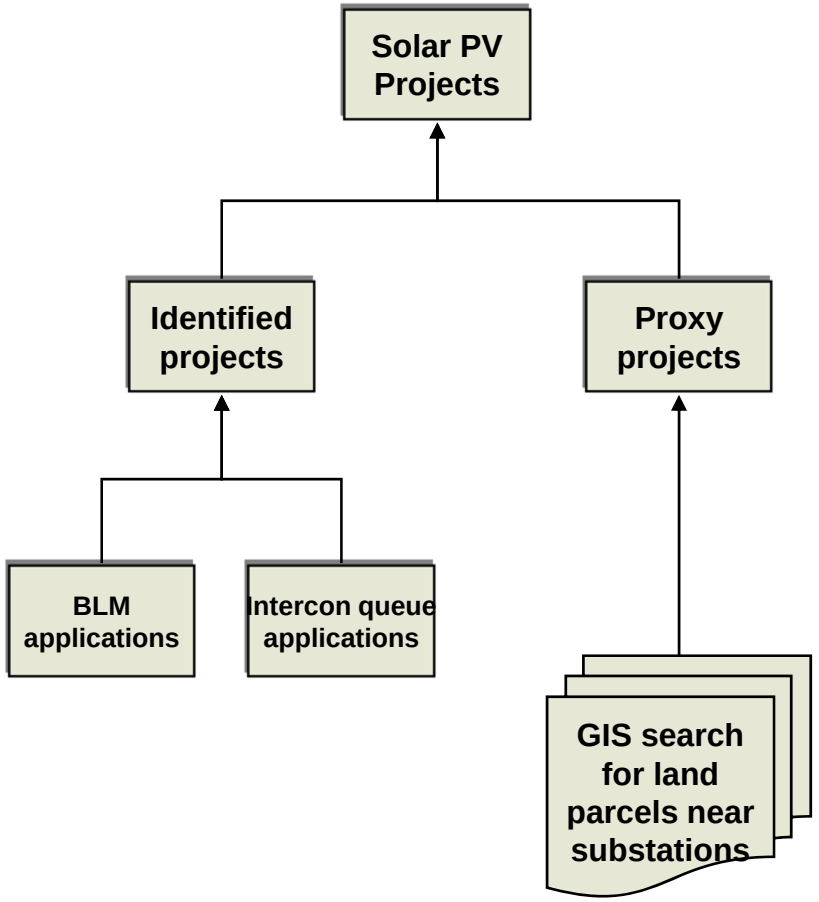
Plant Performance

Performance characteristics will be calculated by NREL's Solar Advisor Model (SAM)

- Capacity factor and production profile
- Insolation and meteorological data from satellite-derived data in the National Solar Radiation Database (NSRDB)
- Enough SAM simulations will be performed to capture climate effects on performance.
  - Where simulations are not performed for a project's specific site, the performance characteristics of a nearby performance run will be scaled based on the difference in monthly average insolation and latitude.

Project Identification and Characterization Solar Photovoltaic

- Identify solar PV projects from existing data sources
  - BLM applications
  - Interconnection queue applications
  - Generators and other sources
- Create proxy projects using GIS analysis
  - Agricultural or barren land near substations
  - Excluding environmentally sensitive areas

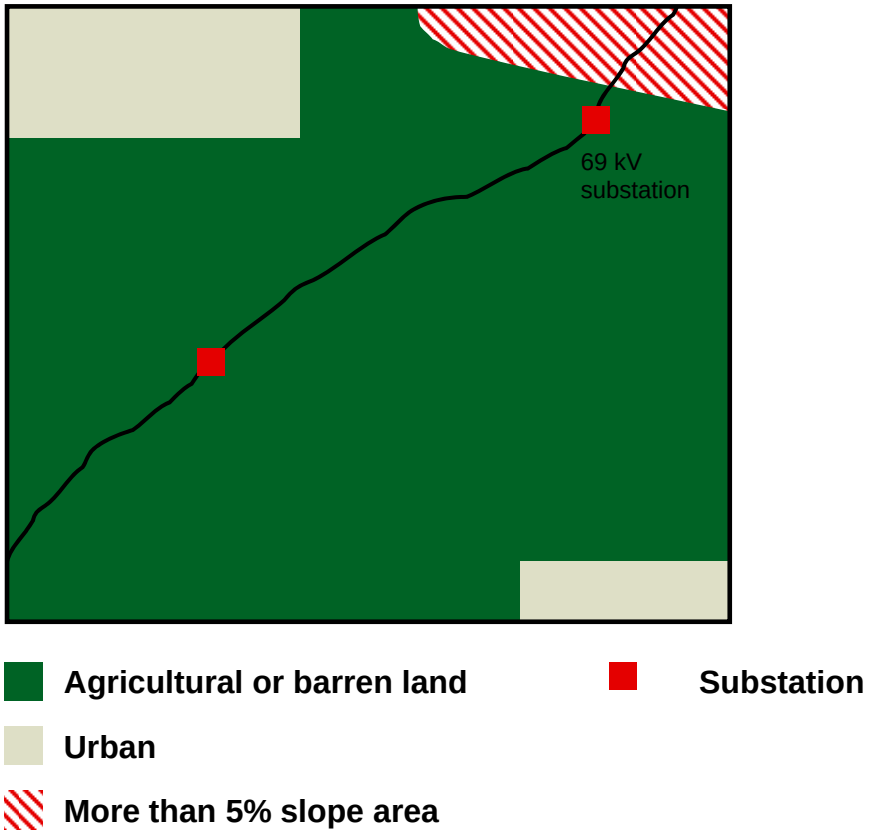


Project Identification and Characterization – Solar Photovoltaic Proxy Projects

Proxy Projects

- Initial criteria
  - near substations
  - agricultural or barren land
  - less than 5% slope

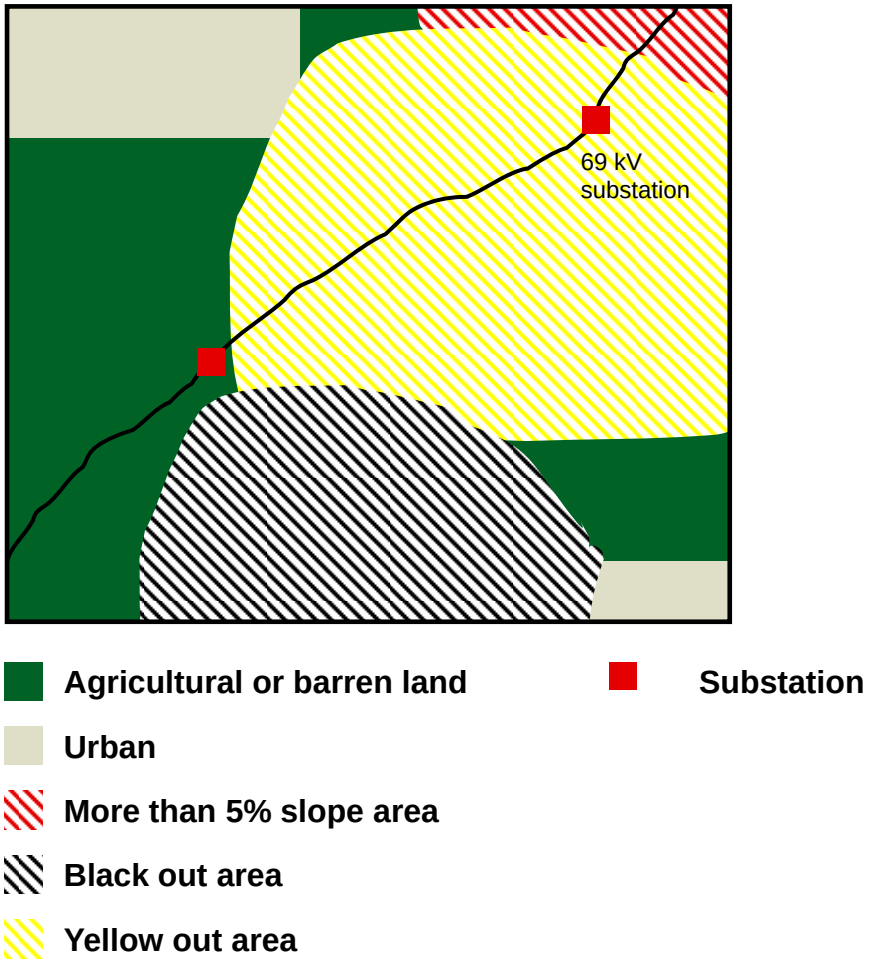
Example Map for Solar PV Proxy Projects



Project Identification and Characterization – Solar Photovoltaic

- Initial criteria
  - near substations
  - agricultural or barren land
  - less than 5% slope
- Environmental screen
  - Black out areas
  - Yellow out areas

Example Map for Solar PV Proxy Projects

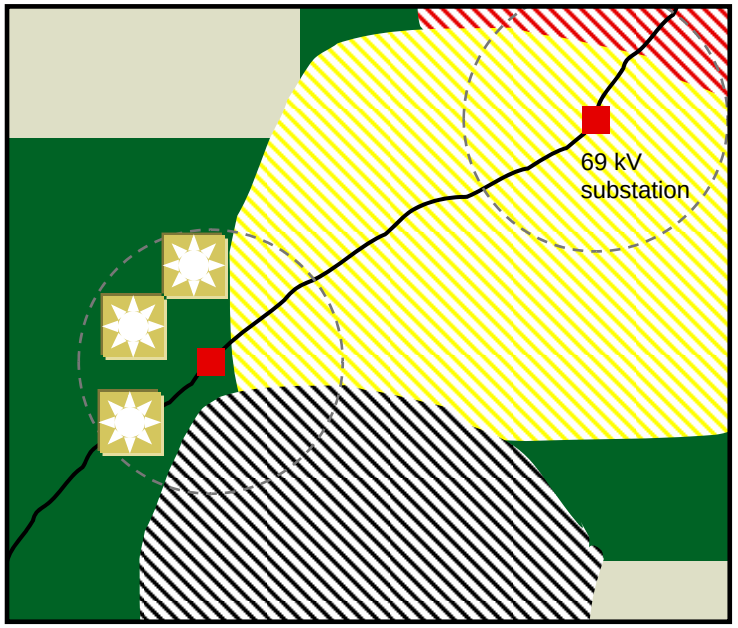


CONCEPTUAL – FOR EXAMPLE ONLY

Project Identification and Characterization – Solar Photovoltaic

- Initial criteria
  - near substations
  - agricultural or barren land
  - less than 5% slope
- Environmental screen
  - Black out areas
  - Yellow out areas
- Land parcels
  - Continuous 100 acre plots (20 MWp)
  - As close to substation as possible

Example Map for Solar PV Proxy Projects

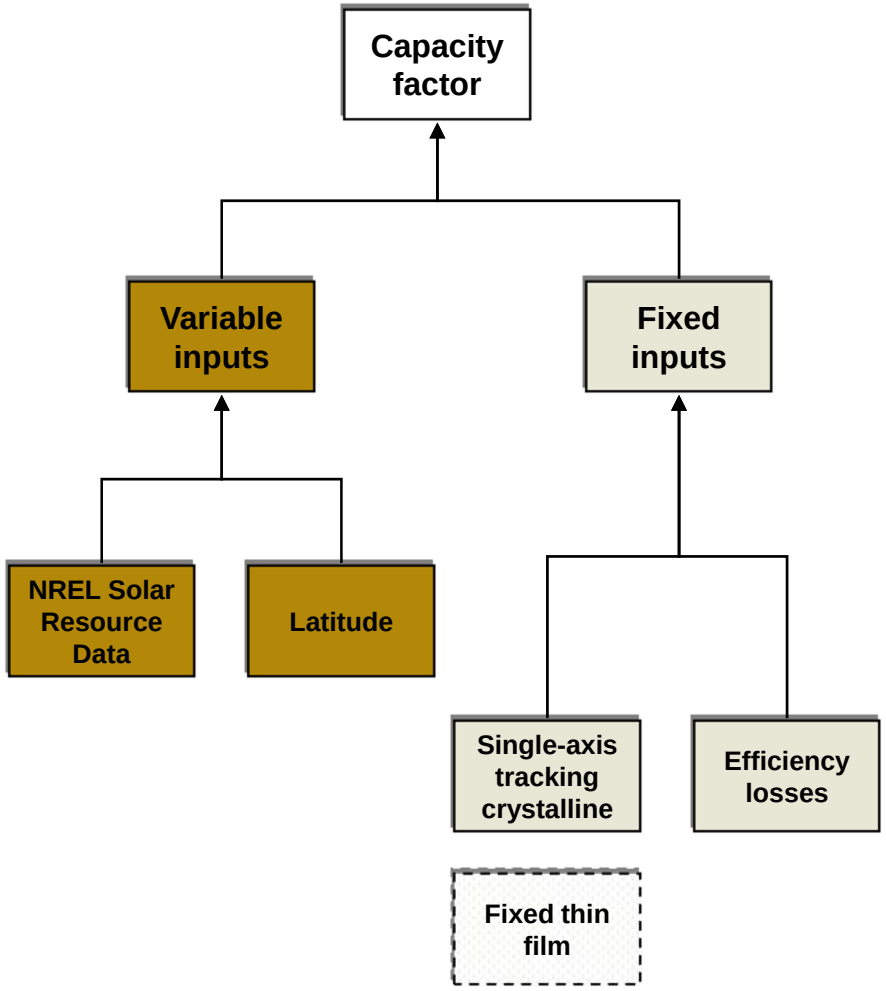


CONCEPTUAL – FOR EXAMPLE ONLY

Project Identification and Characterization – Solar Photovoltaic

Capacity Factor

- Variable inputs
  - High resolution NREL GIS solar data with monthly averages
  - Latitude for determining path of the sun
- Fixed inputs
  - Technology assumption
    - Base case: Single axis tracking crystalline
    - Sensitivity case: Fixed thin film
  - Efficiency losses to include soiling, inverter, wiring and other loss mechanisms



Project Identification and Characterization – Solar Photovoltaic

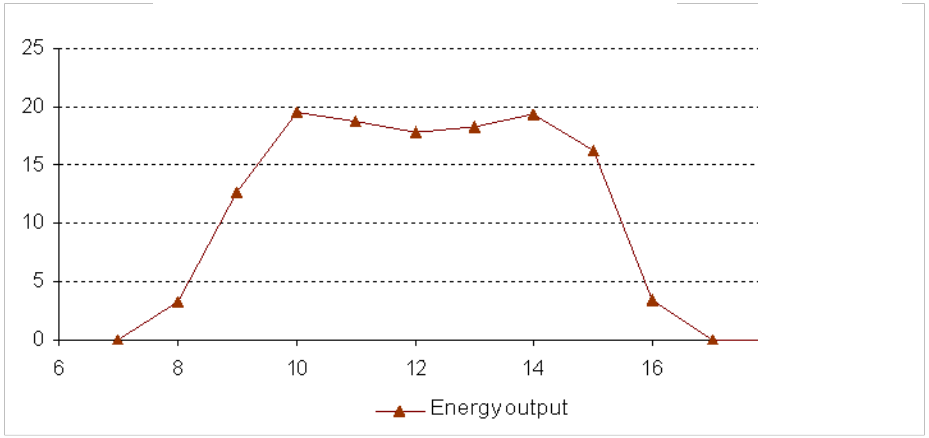
- Capital Cost
  - Equipment
    - Modules
    - BOS
  - Labor, Shipping…
- O&M
  - Washing
  - Inspections
  - Replacements
  - Land leasing

Project Identification and Characterization – Solar Photovoltaic

Production profile

- 12 x 24
  - Typical 24 hour production profile for each month
- Production profile variation drivers
  - Month of year
  - Latitude
  - Single axis vs. fixed tilt
  - Temperature (minor)

Example solar PV production profile single axis tracking (winter)



CONCEPTUAL – FOR EXAMPLE ONLY

Wind Projects - Siting

Identified Projects

RETI will model projects in California for which there is commercial interest. The list will be consolidated from:

- Bureau of Land Management applications
  - Precise location where available, approximate location based on description where necessary
- CAISO and POU transmission queues
  - Approximate location based on nearest reasonable site to interconnection point.
- Other publicly available data sets (PPAs and permitting)
- Generator-provided data

Wind Projects - Siting

Proxy Projects

- Based on available land not identified or connected with other project data
- Meet requirements for wind resource, terrain, environmental sensitivity, military restrictions, etc.
- Best projects selected first

Out of State Projects

- Out-of-state projects will be modeled by wind class, considering competing demand and a discount for “developability”
- Subject to import limitations

Wind Projects - Characterization

Capital Costs

- Reference balance of plant construction costs developed for several types of project sites
  - Flat terrain, several rows of turbines
  - Intermediate terrain types
  - Mountainous terrain, turbines on ridgeline
- Wind turbine price assumed to be uniform for all project types
- Cost adjustment for distance of site from major roads and highways

Wind Projects - Characterization

Plant Performance

Performance characteristics will be based on the California wind map and data from the Intermittency Analysis Project

- Capacity factor calculated for number of MW at each wind speed, based on California wind map (adjusted to 80-m hub height)
- General wind turbine power curves used
  - Representative power curves for IEC design classes (I, II, and III)
  - Adjustment of power curves based on average temperature in area and project site elevation
- Losses applied, wake losses based on terrain type and project size
- Production profile by region from Intermittency Analysis Project data

Biomass Projects - Siting

- California Biomass Collaborative 2010 technically feasible capacity by county as basis for supply
  - Breakdown by agricultural residues, forest residues, and urban wood waste; subdivisions in each
- Determined maximum potential MW from supply using 85% capacity factor and 13,650 BTU/kWh heat rate
  - Reduced by assuming 1/3rd of maximum supply available for power generation (remainder for competing uses)
  - Minimum project size set at 20 MW for economic feasibility

Biomass Projects - Siting

- For each county: Determined if specific subtypes of biomass could meet 20 MW threshold; if not, grouped together
  - Example: Vegetable crop subtype of agriculture
- If none of the three major types of biomass within a county can meet the 20 MW threshold, group together in a multi-fuel plant
- Use remaining material to consider multi-county plants
- Assume siting at substations (specific parcels will not generally be identified)

Biomass Project Examples (Single County Projects)

Project	County	Generation Capacity (MW)	Biomass Fuel(s)
1	Butte	22	Composite Agricultural Residues
2	Colusa	23	Field/Seed Crop Residues
3	El Dorado	34	Composite Wood Residues
4	Fresno	24	Field/Seed Crop Residues
5	Fresno	27	Composite Agricultural Residues
6	Fresno	24	Composite Wood Residues
7	Glenn	22	Composite Agricultural Residues
8	Humboldt	37	Forest Thinnings
9	Humboldt	24	Forest Slash
10	Imperial	21	Multifuel
11	Kern	21	Field/Seed Crop Residues
12	Kern	22	Composite Wood Residues
13	Kings	21	Field/Seed Crop Residues
14	Lassen	39	Composite Wood Residues

PRELIMINARY – FOR DISCUSSION

Biomass Projects - Characterization

- Major project characteristics:
  - Capital cost – function of plant size, fuel type, emissions control requirements (environmental may affect siting also)
  - Fuel cost – function of fuel type and estimated average transport distance
  - Heat rate – function of fuel type (moisture content)

Transmission Assumptions

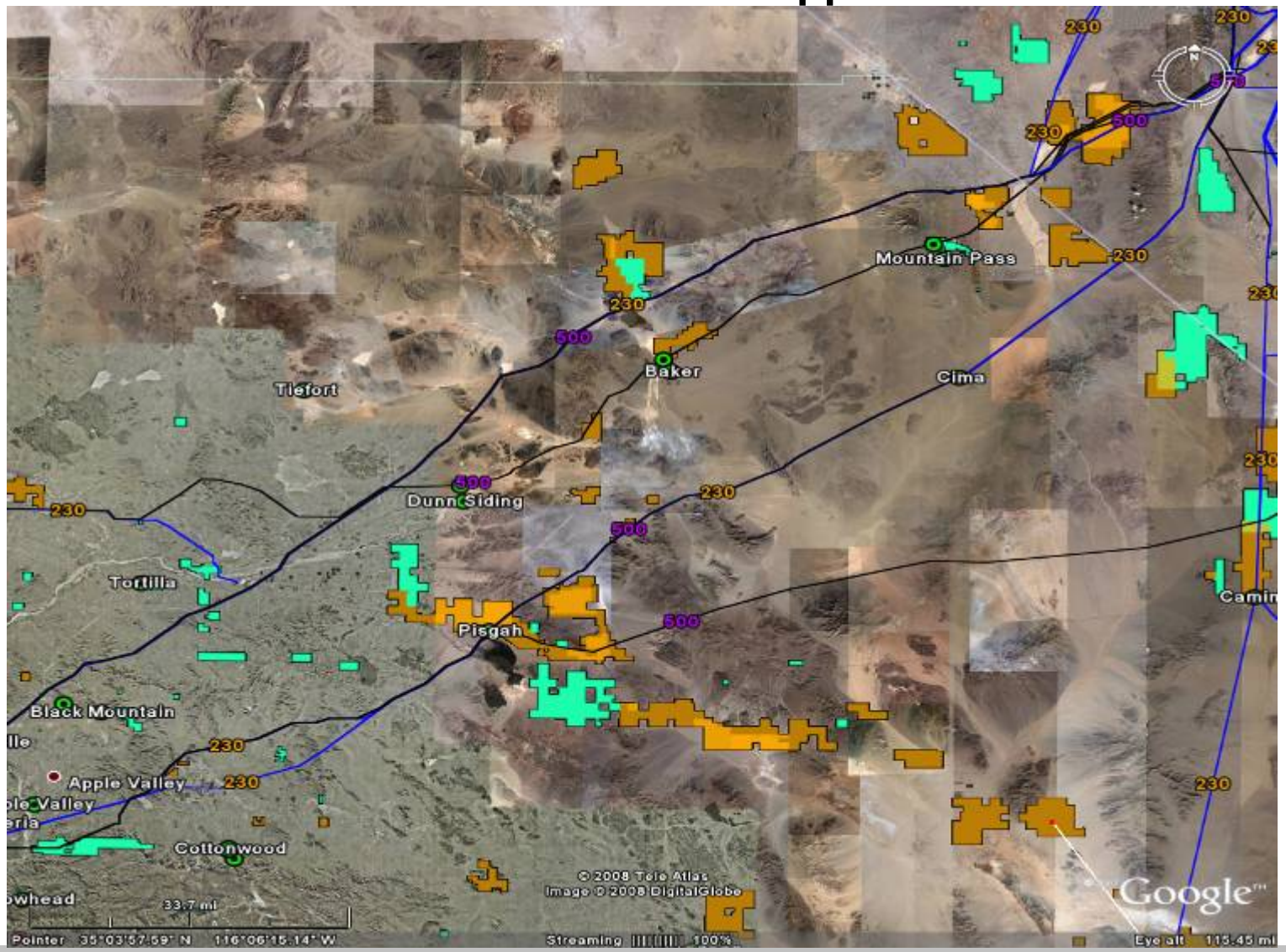
- Transmission system will largely use existing substations as basis for CREZ design
  - Existing substations and lines used to place new transmission if possible in order to minimize new ROW
- Use TRCR data where possible and applicable
- New transmission cost data – B&V estimates

Transmission Cost Assumptions

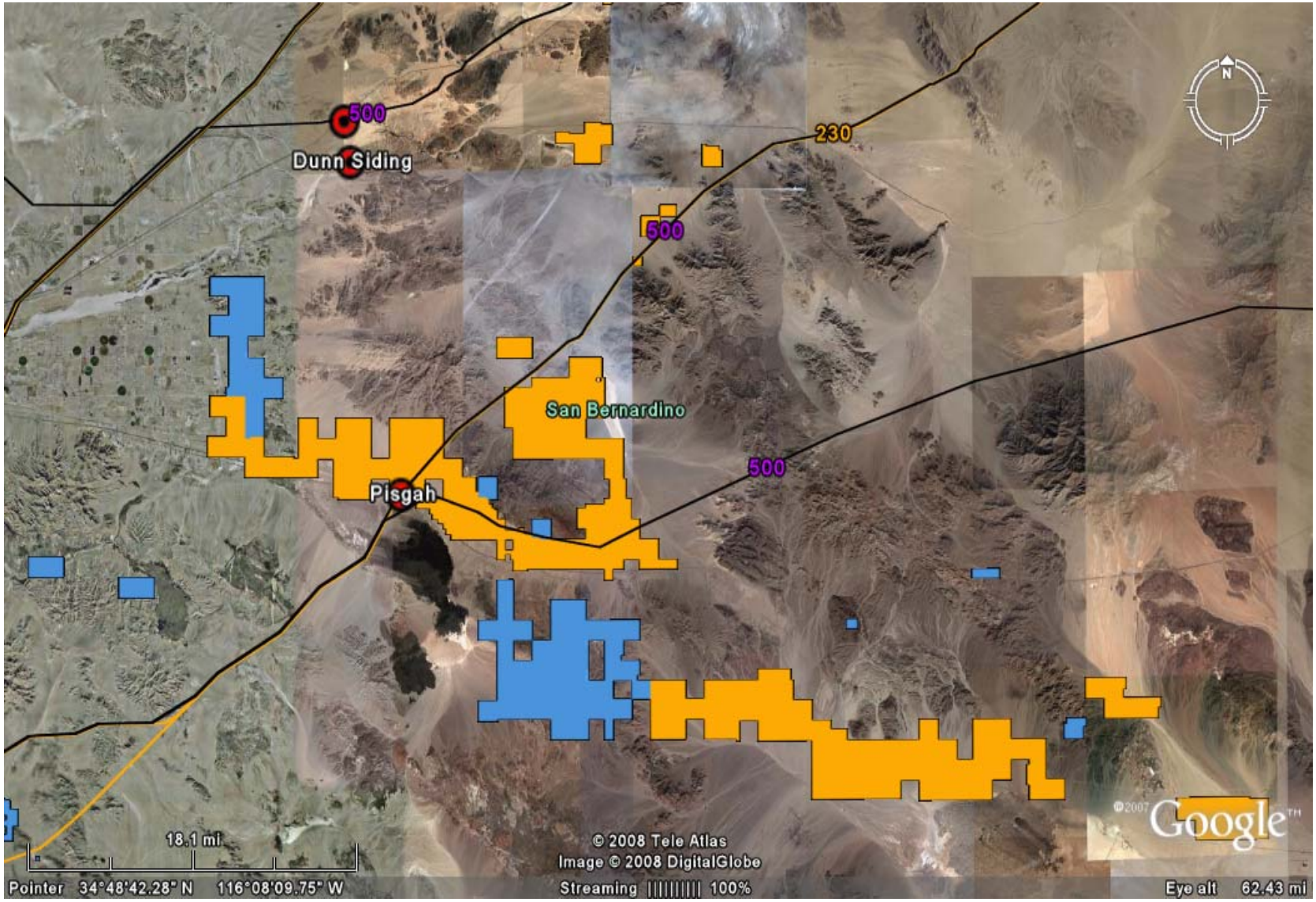
Gen-tie (part of facility cost)	Connection to nearest substation (Collector point) - new or existing
	Equipment costs based on facility size (i.e. 50 MW, 50-200 MW, >200 MW)
Collector Point	New or existing substation upgraded. Station capacity based on total MW of projects
Trunk line	Connects connector points to existing HV transmission
	Line size based on total resource capacity (345 kV or 500 kV)
	Alignment based on existing lines where possible
	Cost = $/MW-mile based on terrain
HV Substation	New or existing substation upgraded. Station capacity based on total MW of projects
Network Costs	Grid interconnection costs. Use TRCR cost if HV substation is named.

Transmission – Pisgah Example

Southern California BLM Solar and Wind Applications



Transmission – Pisgah Example



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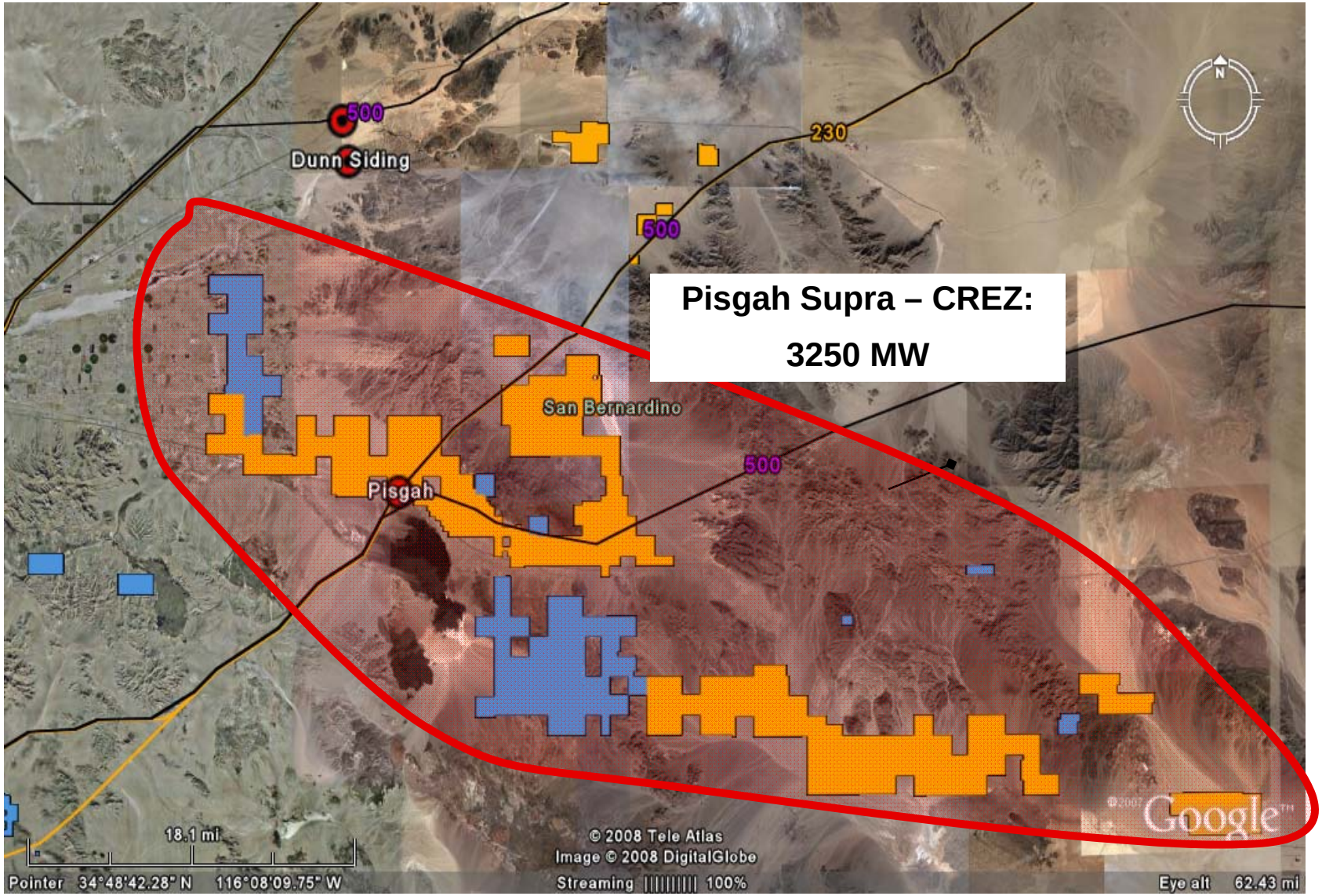

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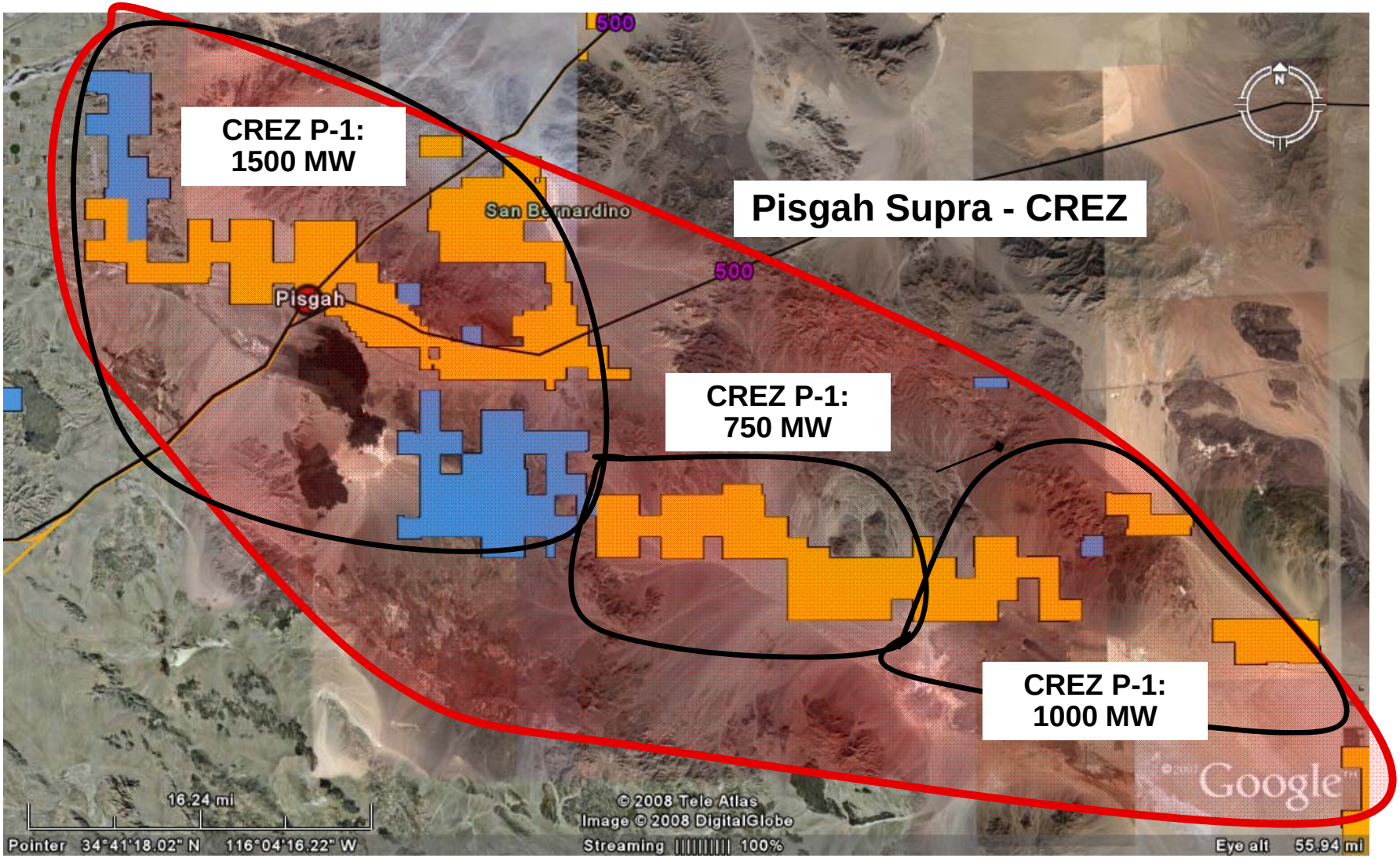

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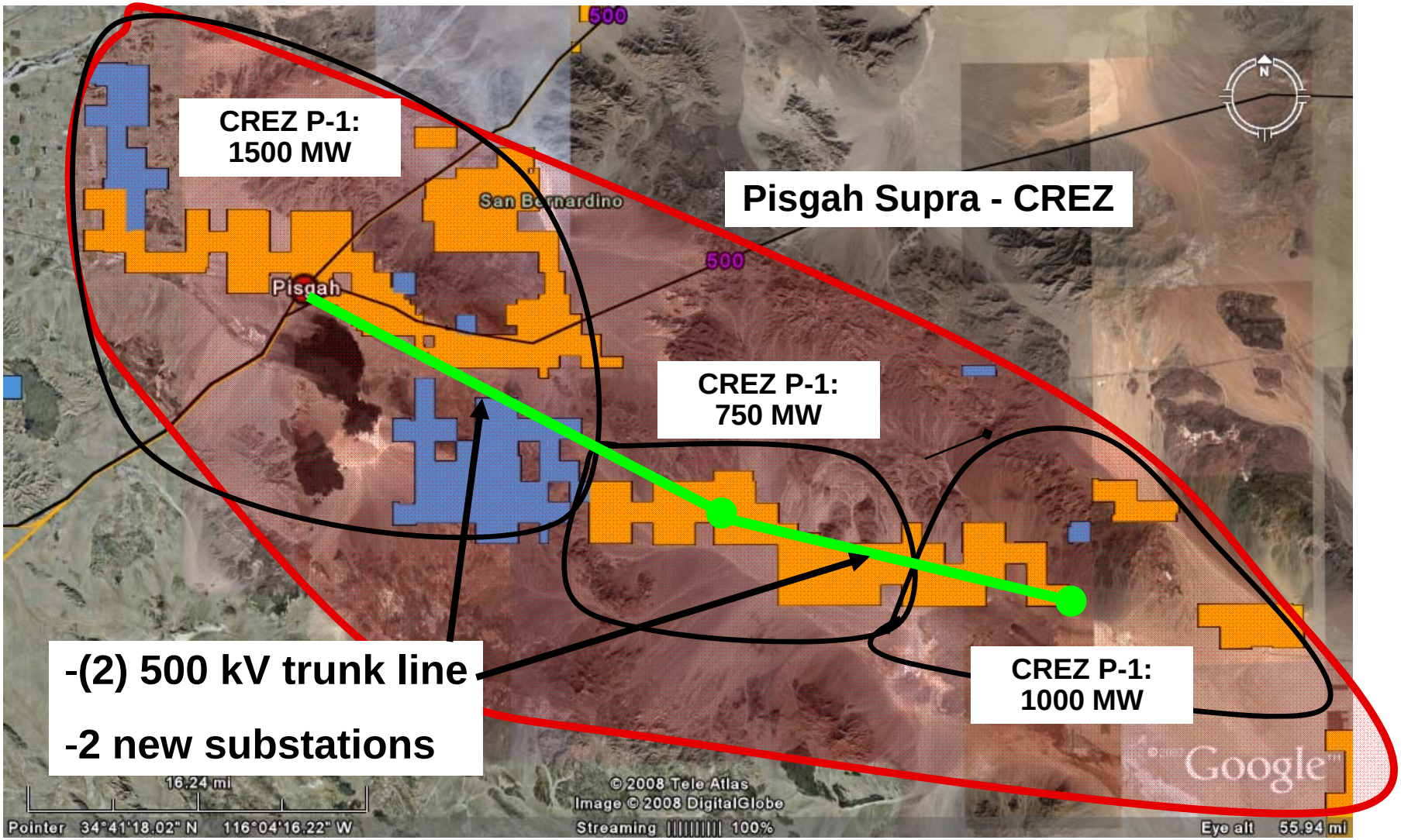

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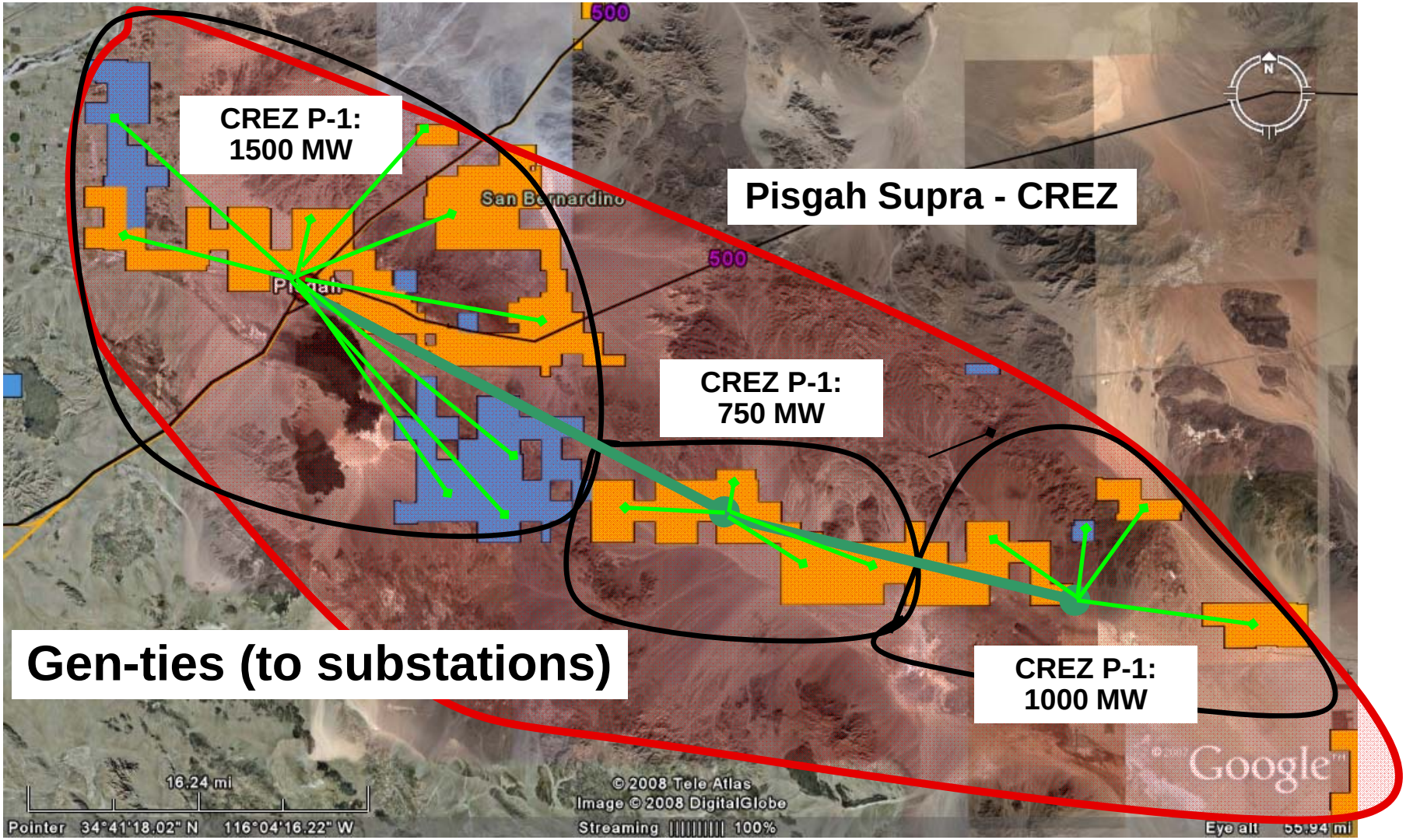

Transmission – Pisgah Example

Item	CREZ I Resource	CREZ 2 Resource	CREZ 3 Resource	Total
Development Timeframe	Near term	Mid-term	Mid-Term	
Size (Total MW)	1500	750	1000	3250
Available Capacity	1061	3579		4640
Network Cost ($ MM)	332	1035		1367
Substation Cost ($ MM)	-	15	25	40
Trunk Lind Distance (miles)	-	40	70 (40+30)	
Trunk Line ($ MM)	0	80	140	220
MW Developed	1000	1250	1000	3250

Notes:

•Only 1000 MW could be developed in CREZ P-1 in near-term . Remainder developed in mid-term

•Trunkline costs considered in project economics, though individual projects would likely not pay these costs

Note: Resource capacity examples illustrative





Thank You!

Ryan Pletka

pletkarj@bv.com

Tel: 925-949-5929

Tim Mason

masont@bv.com

Tel: 925-949-5943